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An Annotated Bibliography of Bitterbrush (*Purshia Tridentata* (Pursh) DC.)

Compiled by Joseph V. Basile

RESEARCH PAPER INT - 44, 1967
Intermountain Forest and Range
Experiment Station
Ogden, Utah

COVER PHOTO: Bitterbrush covering on the Boise River winter deer range at Spring Shores State Park, Boise County, Idaho.

U.S. Forest Service
Research Paper INT-44
1967

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JOSEPH V. BASILE has been associate plant ecologist on Intermountain Station's research project on Northern Rocky Mountain Grasslands, located in Bozeman, Montana, since 1963. Previously he had been a member of a research project on revegetation of big game ranges in southern Idaho, and had also served as a biologist with the Idaho Fish and Game Department. He has published several articles on bitterbrush.

FOREWORD

Bitterbrush, a highly nutritious shrub relished by big game and livestock, is an important browse component on many western ranges. Because it has been seriously depleted over much of its range, considerable attention has been focused on restoring bitterbrush through revegetation and management programs. This bibliography is intended to aid persons engaged in these programs.

This compilation did not result from intensive, methodical searching of the literature; rather, it represents an assortment of references accumulated over several years of working with bitterbrush. Thus, several informative references may have been missed. I hope the reader will call any such omissions to my attention.

Much that has been written about bitterbrush is contained in mimeographed reports that have had a very limited distribution and are not readily available; these reports have not been included in this bibliography.

AN ANNOTATED BIBLIOGRAPHY OF BITTERBRUSH
(*Purshia tridentata* (Pursh) DC.)

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ALDOUS, A. E., and H. L. SHANTZ. 1924. Types of vegetation in the semiarid portion of the United States and their economic significance. J. Agr. Res. 28(2): 99-128, illus.

The bitterbrush type is of moderate value for producing grain crops under proper cultivation but without irrigation--crops "more valuable than the natural vegetation." Carrying capacity of the bitterbrush type is 20 to 30 cows per square mile.

ALDOUS, C. M. 1945. A winter study of mule deer in Nevada. J. Wildlife Manage. 9(2): 145-151.

Bitterbrush utilization (51 percent) occupied an intermediate position between *Cercocarpus ledifolius* (100 percent) and *Cowania stansburiana* (38 percent). Chemical analysis of bitterbrush showed that most nutrients are concentrated in leaves, buds, and twig tips.

ANDERSON, E. WILLIAM. 1956. Some soil-plant relationships in eastern Oregon. J. Range Manage. 9(4): 171-175, illus.

Delineates eastern Oregon into nine natural subdivisions on the basis of broad soil-plant relationships and mentions bitterbrush as a commonly occurring plant in two of these subdivisions.

BAKER, F. S., and CLARENCE F. KORSTIAN. 1931. Suitability of brush lands in the intermountain region for the growth of natural or planted western yellow pine forests. U.S. Dep. Agr. Tech. Bull. 256, 82 pp., illus.

Discusses the root system, leaf size, water content, transpiration index, and sap density of bitterbrush to indicate its strong resistance to drought.

BARON, FRANK J., EAMOR C. NORD, ANTHONY B. EVANKO, and WILLIAM J. MAKEL. 1966. Seeding conifers and buffer crops to reduce deer depredation. U.S. Forest Serv. Res. Note PSW-100, 8 pp.

Simultaneous seedings of ponderosa pine, browse (including bitterbrush), grasses, and legumes produced satisfactory stands. The interplanted shrubs and herbaceous species provided forage for deer and reduced deer use on pine seedlings. Bitterbrush stocking and survival rates were lower on terraced than on nonterraced sites.

BASILE, JOSEPH V., and ROBERT B. FERGUSON. 1964. Say stink bug destroys bitterbrush seed. J. Range Manage. 17(3): 153-154, illus.

Feeding of the Say stink bug (*Chlorochroa sayi* Staal) on ripening bitterbrush seed completely blackens the seed and renders them nongerminable.

BASILE, JOSEPH V., ROBERT B. FERGUSON, and MALCOLM M. FURNISS. 1964. Six-legged seed eaters. Idaho Wildlife Rev. 17(3): 5-7, illus.

A popular article on several species of insects that collectively destroyed about one-third of the potential seed crop of bitterbrush in the 1 year of study.

BASILE, JOSEPH V., and RALPH C. HOLMGREN. 1957. Seeding-depth trials with bitterbrush (*Purshia tridentata*) in Idaho. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Pap. 54, 10 pp.

Depth and rate of seeding affect the date of seedling emergence and the likelihood of seedling mortality from frost heaving.

BASILE, JOSEPH V., and SELAR S. HUTCHINGS. 1966. Twig diameter-length-weight relations of bitterbrush. J. Range Manage. 19(1): 34-38, illus.

Relations between twig diameters and their lengths and weights are sufficiently consistent to permit estimates of utilization on either a length or weight basis solely from postbrowsing measurements.

BEATH, O. A., and J. W. HAMILTON. 1952. Chemical composition of Wyoming forage plants. Wyo. Agr. Exp. Sta. Bull. 311, 40 pp.

Mentions bitterbrush in a community description.

BEETLE, A. A. 1961. Range survey in Teton County, Wyoming. I. Ecology of the range resources. Wyo. Agr. Exp. Sta. Bull. 376, 42 pp.

Mentions bitterbrush in a community description.

BILLINGS, W. D. 1952. The environmental complex in relation to plant growth and distribution. Quart. Rev. Biol. 27(3): 251-265.

In the western Great Basin region, bitterbrush rarely sprouts from the roots; thus, it is generally eradicated permanently by fire.

BISSELL, HAROLD D., BRUCE HARRIS, HELEN STRONG, and FRANK JAMES. 1955. The digestibility of certain natural and artificial foods eaten by deer in California. Calif. Fish and Game 41(1): 57-78.

Presents results of deer digestion trials with alfalfa, barley, live oak, chamise, sagebrush, and bitterbrush in various combinations. Discusses caloric and water intakes; concludes that bitterbrush is the only type of browse studied that can be eaten as the sole item in the diet for prolonged periods.

BISSELL, HAROLD D., and HELEN STRONG. 1955. The crude protein variations in the browse diet of California deer. Calif. Fish and Game 41(2): 145-155.

Crude protein levels (dry-weight basis) at various times of the year were determined for 48 browse species. Protein content of bitterbrush varied from 6.9 percent in February and March to 11.4 percent in August (no data given for June, July, and September). A 7-percent crude protein level is believed adequate for deer maintenance except for periods of prolonged cold or stress.

BLAISDELL, JAMES P. 1950. Effects of controlled burning on bitterbrush on the Upper Snake River Plains. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Pap. 20, 3 pp.

Fifteen years after burning, numbers of bitterbrush plants varied inversely with intensity of burn, and production (lbs./acre) roughly paralleled plant numbers. Much of the increase in bitterbrush numbers has been from seed. Sprouting ability of the shrubs varied inversely with burn intensity.

BLAISDELL, JAMES P. 1953. Ecological effects of planned burning of sagebrush-grass range on the Upper Snake River Plains. U.S. Dep. Agr. Tech. Bull. 1075, 39 pp., illus.

Fifteen years after burning, bitterbrush yields (leaves and current growth) were still significantly lower on burned than on unburned areas. Yields on moderate and heavy burns were significantly lower than yield on the light burn. The incidence of root-sprouting was related to intensity of burning. Sprouts grew rapidly and gained a position of dominance in 9 years.

BLAISDELL, JAMES P. 1958. Seasonal development and yield of native plants on the Upper Snake River Plains and their relation to certain climatic factors. U.S. Dep. Agr. Tech. Bull. 1190, 68 pp., illus.

Based on data for a 23-year period, gives information on seasonal and yearly variations in yields as affected by climate, and suggests methods for estimating opening date for grazing and the yields to be expected. Includes 7 years' data on bitterbrush phenology.

BLAISDELL, JAMES P., and WALTER F. MUEGGLER. 1956. Effect of 2, 4-D on forbs and shrubs associated with big sagebrush. J. Range Manage. 9(1): 38-40.

Bitterbrush was unharmed on four areas sprayed with 2, 4-D and only slightly damaged on a fifth area.

BLAISDELL, JAMES P., and WALTER F. MUEGGLER. 1956. Sprouting of bitterbrush (Purshia tridentata) following burning or top removal. Ecology 37(2): 365-370, illus.

Fifty percent and seventy-two percent, respectively, of plants that had been burned and of plants that had been severed 2 inches above ground level produced sprouts. Sprout mortality equaled 33 percent and 25 percent on the burned and severed plants, respectively, within 16 months after treatment. Sprouts originated in two ways: from an existing mass of dormant buds wholly or partly encircling the stem at ground level, or from a callus of meristematic tissue formed beneath the bark after treatment and encircling the stem.

BLAISDELL, JAMES P., A. C. WIESE, and C. W. HODGSON. 1952. Variations in chemical composition of bluebunch wheatgrass, arrowleaf balsamroot, and associated range plants. J. Range Manage. 5(5): 346-353.

Presents phenology and chemical composition of bitterbrush at several dates.

BROWN, ELLSWORTH READE. 1958. The use of sodium TCA and Dalapon to control the competition of perennial grasses with bitterbrush seedlings.[1] Master's thesis, Univ. of Idaho, Moscow, 113 pp.

Sodium TCA and Dalapon each controlled perennial grass competition adequately to improve survival and growth of bitterbrush seedlings. Benefits received from treatments would not justify costs of chemical treatments.

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[1] Use of trade names is for identification only, and does not imply endorsement by the U.S. Forest Service.

BROWN, ELLSWORTH READE, and CHARLES F. MARTINSEN. 1959. Browse planting for big game. Wash. State Game Dep. Biol. Bull. 12, 63 pp., illus.

Bitterbrush is one of 18 species considered promising for game range rehabilitation. Fall seedings of bitterbrush are more successful than spring seedings. Seeding depth should be controlled and should vary with soil type. Rodent control is essential. Lack of moisture was the most important cause of seedling mortality. It costs $20 per acre to scalp and seed to bitterbrush and $70 per acre to establish bitterbrush nursery stock.

CALIFORNIA FISH AND GAME COMMISSION, INTERSTATE DEER HERD COMMITTEE. 1954. Eighth progress report on the cooperative study of the Devils Garden interstate deer herd and its range. Calif. Fish and Game 40(3): 235-266, illus.

Fire destroyed extensive stands of bitterbrush and other desirable species, the loss of which contributed to subsequent heavy deer mortality. Data are presented on growth, utilization, and chemical content of bitterbrush and other browse species.

CASEBEER, ROBERT L. 1954. The use of tetramine in bitterbrush revegetation. J. Forest. 52(11): 829-830.

Tetramine afforded very high protection to bitterbrush seed against rodent depredation.

CHADWICK, HOWARD WILLIAM. 1960. Plant succession and big game winter movements and feeding habits in a sand dune area in Fremont County, Idaho. Master's thesis, Univ. of Idaho, Moscow, 121 pp.

Bitterbrush is an important winter feed of big game animals on sand dune areas.

CHADWICK, HOWARD W., and PAUL D. DALKE. 1965. Plant succession on dune sands in Fremont County, Idaho. Ecology 46(6): 765-780.

Bitterbrush is a dominant species in the third, fourth, and fifth of five successional stages of vegetal development on dune sands.

CLARK, EDWIN C. 1955. Observations on the ecology of a polyhedrosis of the Great Basin tent caterpillar *Malacosoma fragilis.* Ecology 36(3): 373-376.

Bitterbrush was used to hatch tent caterpillars.

CLARK, EDWIN C. 1956. The Great Basin tent caterpillar in relation to bitterbrush in California. Calif. Fish and Game 42(2): 131-142.

Defoliation by this insect (*Malacosoma fragilis*) may contribute to the decline of bitterbrush ranges. The feeding period of the insect encompasses the period of maximum physiological activity of the plant. Two consecutive defoliations may kill weaker plants. One caterpillar infestation completely defoliated the bitterbrush on about 35,000 acres.

CLARK, EDWIN C., and CLARENCE G. THOMPSON. 1954. The possible use of microorganisms in the control of the Great Basin tent caterpillar. J. Econ. Entomol. 47: 268-272.

Describes tests of a polyhedrosis virus on the control of caterpillars on bitterbrush.

CLIFF, EDWARD P. 1939. Relations between elk and mule deer in the Blue Mountains of Oregon. Fourth N. Amer. Wildlife Conf. Trans. 1939: 560-569.

Bitterbrush is important in the winter diet of deer and elk.

CLINE, MORRIS G. 1960. A comparison of the root systems of bitterbrush and cliffrose. Master's thesis, Brigham Young Univ., Provo, Utah, 81 pp.

COOK, CLYDE J., C. WAYNE COOK, and LORIN E. HARRIS. 1948. Utilization of northern Utah summer range plants by sheep. J. Forest. 46(6): 416-425, illus.

Discusses summer use of bitterbrush by sheep. Sheep prefer leaves to stems.

COOK, C. WAYNE. 1954. Common use of summer range by sheep and cattle. J. Range Manage. 7(1): 10-13.

Presents data on bitterbrush use by sheep and cattle in Wasatch Mountains of Utah.

COOK, C. WAYNE, and THADIS W. BOX. 1961. A comparison of the loop and point methods of analyzing vegetation. J. Range Manage. 14(1): 22-27, illus.

The line-loop method, compared with the line-point and point-frame methods, overestimated canopy cover for shrubs, including bitterbrush, and underestimated it for grasses.

COOK, C. WAYNE, and L. E. HARRIS. 1950. The nutritive content of the grazing sheep's diet on summer and winter ranges of Utah. Utah State Agr. Exp. Sta. Bull. 342, 66 pp.

Presents data on chemical composition of bitterbrush during early-seed and seed-drop stages.

CORNELIUS, DONALD R., and M. W. TALBOT. 1955. Rangeland improvement through seeding and weed control on east slope Sierra Nevada and on southern Cascade Mountains. U.S. Dep. Agr. Handbook 88, 51 pp.

Mentions that bitterbrush can be damaged by spraying.

COSTELLO, DAVID F. 1944. Important species of the major forage types in Colorado and Wyoming. Ecol. Monogr. 14(1): 107-134.

Bitterbrush is an important part of sagebrush range in western and southwestern Colorado.

COSTELLO, DAVID F., and RAYMOND PRICE. 1939. Weather and plant-development data as determinants of grazing periods on mountain range. U.S. Dep. Agr. Tech. Bull. 686, 31 pp., illus.

Describes phenology and range-readiness indicators for bitterbrush. Readiness indicators include: plants one-half in leaf; flower buds bursting; current twig growth none.

COUNTRYMAN, CLIVE M., and DONALD R. CORNELIUS. 1957. Some effects of fire on a perennial range type. J. Range Manage. 10(1): 39-41, illus.

Six years after wildfire had burned a bitterbrush stand in California, bitterbrush was completely absent from the burned area although it constituted 91 percent of the vegetal cover on the adjacent unburned area.

CRADDOCK, G. W., and C. L. FORSLING. 1938. The influence of climate and grazing on spring-fall sheep range in southern Idaho. U.S. Dep. Agr. Tech. Bull. 600, 41 pp., illus.

Spring-fall grazing by sheep led to serious range depletion, with the degree of depletion directly proportional to the intensity of spring use. Overgrazing increased shrub cover and decreased grass and forb cover. Fall grazing alone had the opposite effect on vegetation cover. Presumably, bitterbrush responded to overgrazing in the same manner as shrubs in general.

CURTIS, JAMES D., and DONALD W. LYNCH. 1957. Silvics of ponderosa pine. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Misc. Pub. 12, 37 pp.

Lists bitterbrush as a common inhabitant of the ponderosa pine type in British Columbia, Washington, Oregon, Idaho, western Montana, and Colorado.

DASMANN, WILLIAM P. 1949. Deer-livestock forage studies on the interstate winter deer range in California. J. Range Manage. 2(4): 206-212, illus.

Discusses utilization of bitterbrush by deer and livestock on a dual-use area.

DASMANN, WILLIAM P. 1951. Some deer range survey methods. Calif. Fish and Game 37 (1): 43-52.

Mentions methods of estimating utilization of bitterbrush.

DASMANN, WILLIAM P., and JAMES P. BLAISDELL. 1954. Deer and forage relationship on the Lassen-Washoe interstate winter deer range. Calif. Fish and Game 40(3): 215-234, illus.

Doe:fawn ratios and fawn survival are strongly related to percentage utilization of bitterbrush. Bitterbrush reproduction is sparse on this heavily used range.

DASMANN, WILLIAM P., and HENRY A. HJERSMAN. 1958. Deer survival and range forage trends on eastern California winter ranges. Calif. Fish and Game 44(1): 51-72.

Discusses the relation of fluctuations in bitterbrush growth and utilization to fawn survival on six deer herd areas over a 7-year period.

DAUBENMIRE, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecol. Monogr. 22(4): 301-330, illus.

The *Pinus ponderosa*/*Purshia tridentata* association is one of four associations that comprise the *Pinus ponderosa* zone.

DAUBENMIRE, REXFORD. 1953. Classification of the conifer forests of eastern Washington and northern Idaho. Northwest Sci. 27: 17-24.

Bitterbrush and *Agropyron spicatum* play a major climax role, and *Poa secunda* plays a minor climax role, in the *Pinus ponderosa*/*Purshia tridentata* association of the *Pinus ponderosa* zone.

DAYTON, WILLIAM A. 1931. Important western browse plants. U.S. Dep. Agr. Misc. Pub. 101, 214 pp.

Presents brief general notes on bitterbrush.

DEALY, J. EDWARD. 1966. Bitterbrush nutrition levels under natural and thinned ponderosa pine. U.S. Forest Serv. Res. Note PNW-33, 6 pp.

Bitterbrush under a natural pine stand had higher ash and nitrogen-free extract and lower crude fiber content than that under thinned stands. Crude fat appeared to be higher under the natural stand, and crude protein was the same under natural and thinned stands.

DICKSON, B. A. 1952. A chronosequence of soil and vegetation on recent mudflow deposits on the lower slopes of Mount Shasta, California. Ph.D. diss., Univ. of Calif., Berkeley.

(See Dickson and Crocker 1953.)

DICKSON, B. A., and R. L. CROCKER. 1953. A chronosequence of soils and vegetation near Mt. Shasta, California. J. Soil Sci. 4(2): 123-154.

Bitterbrush is considered "moderately effective" as a soil-forming agent on the mudflows studied. Its frequency of occurrence was 100, 20, and 48 on mudflows 27, 205, and 1200+ years old, respectively. Bitterbrush was absent from the 60- and 566-year-old flows.

DIETZ, DONALD R. 1958. Seasonal variation in the nutritive content of five southwestern Colorado deer browse species. Master's thesis, Colo. State Univ., Fort Collins, 111 pp.

DIETZ, DONALD R. 1965. Deer nutrition research in range management. Thirtieth N. Amer. Wildlife and Natur. Resources Conf. Trans. 1965: 274-285.

The leaves of bitterbrush contained higher percentages of protein, phosphorus, carotene, fat, nitrogen-free extract, ash, and calcium than the stems in late spring. Protein, phosphorus, crude fat, and crude fiber levels, and their implications in deer management are discussed for several species including bitterbrush.

DIETZ, DONALD R., ROBERT H. UDALL, HAROLD R. SHEPHERD, and LEE E. YEAGER. 1959. Seasonal progression in chemical content of five key browse species in Colorado. Soc. Amer. Forest. Proc. 1958: 117-122.

Moisture, ash, calcium, phosphorus, crude fat, crude fiber, crude protein, NFE, and carotene were determined for seasonal collections of bitterbrush, big sagebrush, mountain-mahogany, Gambel oak, and serviceberry. The seasonal changes in chemical composition and their management implications are disussed.

DIETZ, DONALD R., ROBERT H. UDALL, and LEE E. YEAGER. 1962. Chemical composition and digestibility by mule deer of selected forage species, Cache la Poudre Range, Colorado. Colo. Game and Fish Dep. Tech. Pub. 14, 89 pp.

Effects of species, seasons, and years on chemical composition of summer range and winter range plants are compared. Results of feeding trials with deer are presented. Bitterbrush is one of the species studied in detail.

DIETZ, DONALD R., ROBERT H. UDALL, and LEE E. YEAGER. 1962. Differential digestibility of nutrients in bitterbrush, mountainmahogany, and big sagebrush by deer. First Nat. White-tailed Deer Dis. Symp. 1962: 29-36, 39-50, illus.

Sagebrush had higher percentages of digestible protein, fat, and fiber, and more TDN with a better nutritive ratio than bitterbrush and mountainmahogany. Mountainmahogany had higher digestion coefficients than bitterbrush for protein, fat, and fiber; equal in TDN, but with a slightly better nutritive ratio. Bitterbrush and alfalfa were more palatable to the deer than either sagebrush or mountainmahogany. Deer either gained or maintained weight on all feeding combinations, except that with sagebrush, indicating a need for other browse on sagebrush ranges.

DIXON, JOSEPH S. 1934. A study of the life history and food habits of mule deer in California. II. Food habits. Calif. Fish and Game 20: 315-354.

Lists for approximately 200 plant species the plant parts eaten by mule deer, the chief season of use, and the availability, palatability, and relative importance of the species. The commonly available twigs and leaves of bitterbrush are eaten in winter and are of excellent palatability and great importance.

DRISCOLL, RICHARD S. 1963. A larger bitterbrush. J. Range Manage. 16(2): 82-83.

Describes a bitterbrush plant in Jefferson County, Oregon: main stem circumference, 38 inches; height, 14.2 feet; widest crown diameter, 21.7 feet; narrowest crown diameter, 18.5 feet. Proposes that a "register" for big shrubs be established and proposes a guide for measurement.

DRISCOLL, RICHARD S. 1963. Sprouting bitterbrush in central Oregon. Ecology 44(4): 820-821, illus.

Gives percentages of bitterbrush sprouting after two fires. The degree of sprouting was strongly related to soil factors but only weakly related to burn intensity.

DRISCOLL, RICHARD S. 1964. A relict area in the central Oregon juniper zone. Ecology 45(2): 345-353.

Study of two associations--*Juniperus*/*Purshia*/*Agropyron* and *Juniperus*/*Artemisia*/*Agropyron*--revealed that bitterbrush is specific to coarse-textured, stony soils overlying cracked bedrock, whereas big sagebrush is specific to finer textured, nonstony soils with dense, clayey subsoils.

DRISCOLL, RICHARD S. 1964. Vegetation-soil units in the central Oregon juniper zone. U.S. Forest Serv. Res. Pap. PNW-19, 60 pp., illus.

Gives a detailed description of vegetation and soil characteristics of the central Oregon juniper zone, including a key to its plant associations and a discussion of applications of the findings to range and wildlife habitat management. Bitterbrush is a component of some of the described associations.

DYRNESS, C. T., and C. T. YOUNGBERG. 1966. Soil-vegetation relationships within the ponderosa pine type in the central Oregon pumice region. Ecology 47(1): 122-138.

Bitterbrush is an important component in four of six plant communities studied. These four communities are the lowermost both in elevation and in effective moisture. Depth and time of onset of soil drought are important in controlling distribution of plant communities in the study area.

DYRNESS, CHRISTIAN THEODORE. 1960. Soil-vegetation relationships within the ponderosa pine type in the central Oregon pumice region. Ph.D. diss., Oreg. State Univ., Corvallis, 217 pp.

(See Dyrness and Youngberg 1966.)

EDWARDS, OLIVER T. 1942. Survey of winter deer range, Malheur National Forest, Oregon. J. Wildlife Manage. 6: 210-220.

Bitterbrush is the key species and a reliable indicator of range condition on this dual-use area. Presents data on role of bitterbrush in diet of mule deer and information on insect and rodent damage to bitterbrush.

EGGLER, WILLIS A. 1941. Primary succession on volcanic deposits in southern Idaho. Ecol. Monogr. 11(3): 277-298.

Gives status of bitterbrush in succession on *aa* and *pahoehoe* lava flows.

FERGUSON, ROBERT B. 1962. Growth of single bitterbrush plants vs. multiple groups established by direct seeding. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Note 90, 2 pp.

Browse production, as reflected by plant size after 5 years, was similar regardless of whether one plant or several had become established in a seed spot. Survival beyond the first year is greater for multiples than for single plants.

FERGUSON, ROBERT B. 1967. Relative germination of spotted and nonspotted bitterbrush seed. J. Range Manage. 20(5): 330-331, illus.

Controlled tests showed that germinative capacity of spotted seed of bitterbrush was only 50 to 78 percent of that of nonspotted seed.

FERGUSON, ROBERT B., and JOSEPH V. BASILE. 1966. Topping stimulates bitterbrush twig growth. J. Wildlife Manage. 30(4): 839-841.

Tops of old bitterbrush plants were cut off 3 feet above ground level. The year after treatment, topped shrubs produced nearly nine times as much twig growth as the control shrubs. In subsequent years, topped shrubs outproduced the control shrubs but at declining rates.

FERGUSON, ROBERT B., and JOSEPH V. BASILE. 1967. Effect of seedling numbers on bitterbrush survival. J. Range Manage. 20(6): 380-382, illus.

For spot-seeded bitterbrush, the chance that a seed spot may contain at least one live seedling at the end of the first growing season is directly correlated with the initial number of seedlings that emerge from that spot. Any individual in a group of seedlings that emerges from one spot is more likely to survive than a lone seedling emerging from a spot.

FERGUSON, ROBERT B., MALCOLM M. FURNISS, and JOSEPH V. BASILE. 1963. Insects destructive to bitterbrush flowers and seeds in southwestern Idaho. J. Econ. Entomol. 56 (4): 459-462.

Thrips (*Frankliniella occidentalis*) feeding on buds and flowers destroyed 6.5 percent of the potential seed crop of shrubs selected for study. After seeds had formed, a gall midge (possibly *Phytophaga* spp.) and a gelechiid (*Filatima* spp.) destroyed 6.8 percent and 5 percent, respectively, of the seed crop. The pentatomid bug (*Chlorochroa sayi*) was suspected as the cause of damage to an additional 20 percent of the seed, but proof was lacking.

FERREL, CAROL M., and HOWARD R. LEACH. 1950. Food habits of the prong-horn antelope of California. Calif. Fish and Game 36(1): 21-26.

Bitterbrush contributed 13.7 percent of the diet and occurred in 60 percent of the 20 stomach samples collected between May 29 and June 14. It contributed 10.4 percent of the diet and occurred in 39 percent of the 36 stomach samples collected between August 26 and September 5. *Artemisia tridentata* was the only one of 80 species that contributed more than bitterbrush to the diet of antelope.

FORSLING, C. L., and EARLE V. STORM. 1929. The utilization of browse forage as summer range for cattle in southwestern Utah. U.S. Dep. Agr. Circ. 62, 30 pp.

Discusses the effects of grazing on various classes and species of vegetation, including bitterbrush, and the effects on cattle gains and calf crops. Discusses the carrying capacity of browse range, the best seasons of use, and the extent to which browse should be grazed.

FREMONT, J. C. 1845. Report of the exploring expedition to the Rocky Mountains in the year 1842 and to Oregon and northern California in the years 1843-44. U.S. Congr., Senate Doc. 174, 693 pp.

Reports bitterbrush as a conspicuous plant in several places both east of the mountains and in Oregon and California; this plant sometimes attains a height of 12 feet.

FURNISS, MALCOLM M. 1966. Loopers invade deer browse. Idaho Wildlife Rev. 19(2): 8-9.

The larval stage of *Anacamptodes clivinaria* (family Geometridae) fed and developed normally on bitterbrush in the laboratory.

FURNISS, MALCOLM M., and WILLIAM F. BARR. 1967. Bionomics of *Anacamptodes clivinaria profanata* (Lepidoptera: Geometridae) on mountain mahogany in Idaho. Idaho Agr. Exp. Sta. Res. Bull. 73, 24 pp., illus.

The larval stage of this insect fed and developed normally on bitterbrush in the laboratory, suggesting that bitterbrush may serve as a host in the field. However, it is speculated that bitterbrush may lack sufficient foliage to sustain many larvae, and that starvation would prevent a large increase in the population.

GARRISON, GEORGE A. 1953. Annual fluctuation in production of some eastern Oregon and Washington shrubs. J. Range Manage. 6(2): 117-121, illus.

Reports the annual yields of bitterbrush and four other species over a 5-year period.

GARRISON, GEORGE A. 1953. Effects of clipping on some range shrubs. J. Range Manage. 6(5): 309-317, illus.

Various methods of clipping shrubs stimulated twig production to the detriment of flower and fruit production. Suggests the proper levels of use for sustained production of five shrub species, including bitterbrush.

GARRISON, GEORGE A., and ROBERT S. RUMMELL. 1950. First-year effects of logging on forage production. U.S. Forest Serv., Pacific Northwest Forest and Range Exp. Sta. Res. Note 62, 5 pp.

Bitterbrush is badly injured or killed by logging disturbance.

GARRISON, GEORGE A., and ROBERT S. RUMMELL. 1951. First-year effects of logging on ponderosa pine forest range lands of Oregon and Washington. J. Forest. 49(10): 708-713, illus.

Reports that bitterbrush is severely injured or killed by logging.

GYSEL, LESLIE W. 1960. An ecological study of the winter range of elk and mule deer in the Rocky Mountain National Park. J. Forest. 58(9): 696-703, illus.

Compares bitterbrush cover on four protected vs. four unprotected areas and discusses bitterbrush mortality from mice girdling.

HAGEN, HERBERT L. 1953. Nutritive value for deer of some forage plants in the Sierra Nevada. Calif. Fish and Game 39(2): 163-175.

Bitterbrush collected in August had a crude protein content of 13.7 percent. It is present in limited quantity on the summer range, where it shows evidence of heavy use.

HALL, RALPH C. 1965. Sagebrush defoliator outbreak in northern California. U.S. Forest Serv. Res. Note PSW-75, 12 pp.

The sagebrush defoliator (*Aroga websteri*) has been reared from bitterbrush. However, sagebrush is the principal host of this insect, which feeds on other species only if the sagebrush has been completely defoliated.

HARRY, G. BRYAN. 1957. Winter food habits of moose in Jackson Hole, Wyoming. J. Wildlife Manage. 21(1): 53-57.

Bitterbrush is too low-growing to be considered available to moose, but it is used extensively whenever available and is rated as very high in palatability.

HART, G. H., H. R. GUILBERT, and H. GOSS. 1932. Seasonal changes in the chemical composition of range forage and their relation to nutrition of animals. Calif. Agr. Exp. Sta. Bull. 543, 62 pp.

The chemical composition is given for leaves and twigs of bitterbrush at three different dates. Protein and phosphorous content declined with advancing maturity. Lambs ate bitterbrush eagerly.

HOLMGREN, RALPH C. 1954. A comparison of browse species for revegetation of big-game winter ranges in southwestern Idaho. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Pap. 33, 12 pp.

Compares attributes of bitterbrush with those of 26 other browse species for use in revegetation programs.

HOLMGREN, RALPH C. 1956. Competition between annuals and young bitterbrush (*Purshia tridentata*) in Idaho. Ecology 37(2): 370-377, illus.

Few bitterbrush seedlings survive in cheatgrass stands. The inhibiting influence of broad-leaved annuals reduces vigor of seedling bitterbrush. Proper seedbed preparation minimizes competition from annuals.

HOLMGREN, RALPH C., and JOSEPH V. BASILE. 1956. Range revegetation and deer on the Payette. Idaho Wildlife Rev. 9(2): 10-13, illus.

Discusses effect of excessive deer numbers on bitterbrush seedings.

HOLMGREN, RALPH C., and JOSEPH V. BASILE. 1959. Improving southern Idaho deer winter ranges by artificial revegetation. Idaho Dep. Fish and Game Wildlife Bull. 3, 61 pp., illus.

Describes the "when, where, and how" of revegetating game ranges with bitterbrush, and discusses subsequent management considerations.

HOOVEN, EDWARD F. 1966. Pine regeneration in Oregon: habits and control of seed-eating mammals. Oregon State Univ. Forest Res. Lab. Res. Pap. 5, 24 pp.

Bitterbrush is a major food source for small seed-eating mammals: chipmunk, golden-mantled ground squirrel, chickaree, deer mouse, and silver-gray squirrel. The only bitterbrush germinants found were results of animal caches.

HOOVER, ROBERT L., C. E. TILL, and STANLEY OGILVIE. 1959. The antelope of Colorado. Colo. Dep. Game and Fish Tech. Bull. 4, 110 pp., illus.

Bitterbrush was found frequently and in large quantities (over 90 percent of the volume of seven samples in the mountain-brush type) in stomach samples taken from antelope.

HORMAY, A. L. 1943. A method of estimating grazing use of bitterbrush. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 35, 4 pp.

This method is predicated on a correlation of shrub volume and yield with the product of crown area and average length of ungrazed twigs.

HORMAY, A. L. 1948. Forest grazing in California. Soc. Amer. Forest. Proc. 1947: 286-296.

Mentions bitterbrush in community description.

HORMAY, AUGUST L. 1943. Bitterbrush in California. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 34, 13 pp.

Gives general notes on bitterbrush range, description, forage value, growth, reproduction, and artificial revegetation.

HORMAY, A. L., and M. W. TALBOT. 1961. Rest-rotation grazing. . . a new management system for perennial bunchgrass ranges. U.S. Dep. Agr. Prod. Res. Rep. 51, 43 pp.

Bitterbrush made up 3 percent of the forage production and 11 percent of the cattle diet on summer range; utilization equaled 89 percent. Presents some phenology data for bitterbrush.

HOSKINS, LEONARD W., and PAUL D. DALKE. 1955. Winter browse on the Pocatello big game range in southeastern Idaho. J. Wildlife Manage. 19(2): 215-225.

Bitterbrush is highly preferred by mule deer, with the heaviest use in early winter. Use then tapers off, and sagebrush use increases. Reports rodent girdling of mature bitterbrush under the snow. Cattle use bitterbrush in late August and early September.

HUBBARD, R. L. 1956. Bitterbrush seedlings destroyed by cutworms and wireworms. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 114, 2 pp.

Cutworms destroyed 98 percent of the emerged seedlings at one place.

HUBBARD, R. L., E. C. NORD, and L. L. BROWN. 1959. Bitterbrush reseeding . . . a tool for the game range manager. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Misc. Pap. 39, 14 pp., illus.

A guide to successful seeding of bitterbrush.

HUBBARD, R. L., and H. R. SANDERSON. 1961. Grass reduces bitterbrush production. Calif. Fish and Game 47(4): 391-398, illus.

Competing herbaceous vegetation reduced significantly the yield and vigor of bitterbrush.

HUBBARD, R. L., and H. R. SANDERSON. 1961. When to plant bitterbrush--spring or fall? U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Tech. Pap. 64, 21 pp.

In northeastern California, spring plantings were best where precipitation was adequate and well distributed throughout the germination and emergence period. Fall planting was usually superior in dry years or on dry sites.

HUBBARD, R. L., and E. J. WOOLFOLK. 1961. Deer range management--a complex business. Outdoor Calif. 22(6-7): 11-14, illus.

Although research has shown how to reseed bitterbrush successfully, reseeding is not a substitute for good management. Reseeded stands must be managed more closely than natural stands.

HUBBARD, RICHARD L. 1956. Effect of depth of planting on the emergence of bitterbrush seedlings. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 113, 6 pp., illus.

Seeding depths of 0.5 to 1.5 inches, depending on moisture, gave best emergence. Two inches seems the maximum depth from which bitterbrush emergence may be expected.

HUBBARD, RICHARD L. 1957. The effects of plant competition on the growth and survival of bitterbrush seedlings. J. Range Manage. 10(3): 135-137, illus.

Seedbed preparation, alone and with subsequent weeding, reduced seedling mortality rates and greatly increased the growth of seedlings. Crested wheatgrass is as severe a competitor as native vegetation.

HUBBARD, RICHARD L. 1962. The place of browse seeding in game range management. Twenty-seventh N. Amer. Wildlife Natur. Resources Conf. Trans. 1962: 394-401.

Summarizes findings from a 10-year cooperative study and discusses how results can be applied to improve deer management programs.

HUBBARD, RICHARD L. 1964. A guide to bitterbrush seeding in California. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta.; and Calif. Dep. Fish and Game Resources Agency, 30 pp.

Discusses seed collecting and handling; where, when, and how to plant; pests and ways to combat them; and cost considerations in bitterbrush seeding programs.

HUBBARD, RICHARD L. 1965. The Devil's Garden deer range. . .what we need to know. Outdoor Calif. 4(26): 4-5, illus.

Discusses the lack of natural reproduction of bitterbrush and research plans for increasing natural reproduction by reducing grass competition through cattle grazing.

HUBBARD, RICHARD L., and DAVID DUNAWAY. 1958. Variation in leader length of bitterbrush. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 145, 4 pp.

A random sample of 19 to 39 leaders was required for a reliable estimate of average leader length on the five plants studied.

HUBBARD, RICHARD L., and STURGIS McKEEVER. 1961. Meadow mouse girdling--another cause of death of reseeded bitterbrush plants. Ecology 42(1): 198, illus.

Meadow mice damaged several stands of sagebrush-bitterbrush in 1957 and 1958. The mice killed 5 percent of the plants and damaged 15 percent on a bitterbrush reseeding area.

HUBBARD, RICHARD L., and BENNETT O. PEARSON. 1958. Germination of thiourea-treated bitterbrush seed in the field. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 138, 6 pp.

Thiourea treatment affected the rate of seedling emergence, but had no apparent effect on survival after emergence.

HUBBARD, RICHARD L., H. REED SANDERSON, and DAVID DUNAWAY. 1960. Herbage production and carrying capacity of bitterbrush. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Res. Note 157, 6 pp., illus.

Herbage production data are given for five mature plants, and production is discussed in relation to deer needs.

HUBBARD, RICHARD L., PINHAS ZUSMAN, and H. REED SANDERSON. 1962. Bitterbrush stocking and minimum spacing with crested wheatgrass. Calif. Fish and Game 48(3): 203-208.

Mortality of bitterbrush plants in a 6-year-old seeding was particularly high near a stand of crested wheatgrass. Bitterbrush within 2 feet of the crested wheatgrass was seriously damaged.

HURD, RICHARD M. 1948. A range test of species adaptability. Iowa State Coll. J. Sci. 22(4): 387-394.

From a 1940 bitterbrush seeding near Wells, Nevada, plant numbers averaged 0.7 per square foot in 1941, 0.3 per square foot in 1942, and 0.0 afterwards. Failure was attributed to competition from Bromus tectorum and to weather conditions. Results of nursery plantings of bitterbrush were fair to good with some cultivation.

HYDER, D. N., and FORREST A. SNEVA. 1962. Selective control of big sagebrush associated with bitterbrush. J. Range Manage. 15(4): 211-215.

2,4-D ester was slightly more selective for sage than 2,4,5-T ester. The proper time to spray mixed stands of sagebrush and bitterbrush on dry sites is indicated by the appearance of new leaves on both species and of heads on Sandberg bluegrass. Spraying may continue until bitterbrush is in flower.

IDAHO FISH & GAME DEPARTMENT. 1954. Of mice and men. Idaho Wildlife Rev. 6(6): 4-5.

A popular article on livetrapping and ear-tagging of mice to test the effect of chemical treatment on the palatability of bitterbrush seed to mice.

JENSEN, HERBERT A. 1947. A system for classifying vegetation in California. Calif. Fish and Game 33(4): 199-266.

Bitterbrush is mentioned as a component of the Great Basin sagebrush type.

JUDD, B. IRA. 1962. Principal forage plants of southwestern ranges. U.S. Forest Serv., Rocky Mountain Forest and Range Exp. Sta. Pap. 69, 93 pp., illus.

Describes 89 common grasses, forbs, and shrubs--including bitterbrush--and the major range types in which they occur.

JULANDER, ODELL. 1952. Forage habits of mule deer during the late fall as measured by stomach content analyses. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Note 2, 5 pp.

Bitterbrush constituted a small part of the stomach contents, but this is attributed to a scarcity of bitterbrush in the area. Where bitterbrush is more abundant, it makes up a high percentage of the stomach contents, and plants are heavily utilized in the fall.

JULANDER, ODELL. 1955. Deer and cattle range relations in Utah. Forest Sci. 1(2): 130-139, illus.

Bitterbrush is highly preferred by deer and cattle on both summer and winter ranges and should be considered a key species on dual-use areas.

JULANDER, ODELL. 1958. Techniques in studying competition between big game and livestock. J. Range Manage. 11(1): 18-21, illus.

Cattle utilized bitterbrush considerably in spring and fall on a range where bitterbrush was the most highly preferred winter deer forage.

JULANDER, ODELL, and W. LESLIE ROBINETTE. 1950. Deer and cattle range relationships on Oak Creek range in Utah. J. Forest. 48(6): 410-415.

Bitterbrush is a choice feed on deer winter range. Pellet-group counts showed 86 deer-days use per acre in juniper-bitterbrush-sage type.

KLYVER, F. D. 1931. Major plant communities in a transect of the Sierra Nevada Mountains of California. Ecology 12(1): 1-17.

Bitterbrush is mentioned in community descriptions, with *Purshia tridentata* important in sagebrush and *Purshia glandulosa* a part of fir-lodgepole forests.

KORSTIAN, C. F. 1924. Density of cell sap in relation to environmental conditions in the Wasatch Mountains of Utah. J. Agr. Res. 28(9): 845-907.

Gives depression of freezing point and osmotic pressure of leaf sap for bitterbrush from three locations in Utah.

LEACH, HOWARD R. 1956. Food habits of the Great Basin deer herds of California. Calif. Fish and Game 42(4): 243-308, illus.

Analysis of 978 deer stomachs from four representative winter ranges in the Great Basin of California showed that bitterbrush was eaten heavily on all ranges during October through December but contributed little to the diet for the remainder of the winter. Bitterbrush was the principal item in the summer diet of one of the deer herds.

LEOPOLD, A. STARKER. 1950. Deer in relation to plant successions. J. Forest. 48(10): 675-678.

On the east slope of the Sierra Nevada, sagebrush and bitterbrush have invaded the foothills formerly stocked with bunchgrass. It is believed that similar invasions are widespread in the Great Basin and that they stem from past overuse. An example is given of complications in plant succession: In the Truckee River Canyon of eastern California, logging and recurrent fires stimulated extensive growth of bitterbrush, whereas a few miles down the canyon toward more arid Reno, fire seems to wipe out bitterbrush and give rise to pure stands of cheatgrass.

LONGHURST, WILLIAM M., A. STARKER LEOPOLD, and RAYMOND F. DASMANN. 1952. A survey of California deer herds, their ranges and management problems. Calif. Dep. Fish and Game Bull. 6, 136 pp., illus.

Bitterbrush easily ranks as the key browse species on most winter ranges in the Great Basin area of California. Factors influencing range-carrying capacity in favor of deer are those that disturb climax vegetation. Livestock grazing has been the most important disturbing agent on the Great Basin winter ranges, and has been instrumental in changing the climax bunchgrass association to a mixed shrub association. It isn't known whether deterioration of the sod itself or the preclusion of fire following grazing permitted shrub intrusion.

McCONNELL, BURT R. 1960. Effect of gibberellic acid and cold treatments on the germination of bitterbrush seed. U.S. Forest Serv., Pacific Northwest Forest and Range Exp. Sta. Res. Note 187, 4 pp., illus.

Time required for germination of bitterbrush seed was inversely proportional to acid concentration.

McCONNELL, BURT R. 1961. Notes on some rooting characteristics of antelope bitterbrush. U.S. Forest Serv., Pacific Northwest Forest and Range Exp. Sta. Res. Note 204, 5 pp., illus.

Two types of bitterbrush rooting systems are described. Adaptive characteristics for growth on droughty sites are discussed.

McCONNELL, BURT R., and PAUL D. DALKE. 1960. The Cassia deer herd of southern Idaho. J. Wildlife Manage. 24(3): 265-271.

Bitterbrush occurs in pure and mixed communities in the sagebrush type and furnishes the bulk of the winter forage.

McCONNELL, B. R., and G. A. GARRISON. 1966. Seasonal variations of available carbohydrates in bitterbrush. J. Wildlife Manage. 30(1): 168-172.

Time of grazing should be related to the carbohydrate level to realize maximum plant use while inflicting minimum damage to plant vigor. Grazing is probably most harmful during the carbohydrate depletion stage from the start of spring growth through the period of rapid twig growth and early seed formation. Grazing should be less harmful between seed maturity and leaf fall, a period of carbohydrate accumulation. Grazing should be least detrimental to shrub vigor during the winter dormancy.

McCONNELL, BURT R., and JUSTIN G. SMITH. 1963. Estimating bitterbrush age from stem-diameter measurements. Ecology 44(3): 579-581.

The age of bitterbrush plants can be estimated from the maximum stem diameter at the root crown.

McCONNELL, BURT R., and JUSTIN G. SMITH. 1965. Understory response three years after thinning pine. J. Range Manage. 18(3): 129-132.

Yields of understory plants were significantly greater in thinned stands than in unthinned stands of ponderosa pine. Up to a 45-percent pine canopy, grasses outproduced forbs; when the pine canopy exceeded 45 percent, forbs produced more dry matter than grasses. Shrubs, including bitterbrush, showed a nonsignificant response to thinning.

McCULLOUGH, DALE R., and EDWARD R. SCHNEEGAS. 1966. Winter observations on the Sierra Nevada bighorn sheep. Calif. Fish and Game 52(2): 68-84.

Gives nutrient content of *P. tridentata* and *P. glandulosa*. Rates *P. tridentata* as excellent palatability for bighorn sheep.

McKEEVER, STURGIS, and RICHARD L. HUBBARD. 1960. Use of desert shrubs by jackrabbits in northeastern California. Calif. Fish and Game 46(3): 271-277, illus.

Reports on jackrabbit use of eight shrub species, including bitterbrush.

McNULTY, IRVING B. 1947. The ecology of bitterbrush in Utah. Master's thesis, Univ. of Utah, Salt Lake City.

MACE, ROBERT U. 1949. Oregon's pronghorn antelope. Oregon State Game Comm., 26 pp.

Antelope use bitterbrush heavily in July and August.

MACE, ROBERT U. 1952. Oregon's big game resources. Oregon State Game Comm., 31 pp.

Bitterbrush is a key species on big game ranges.

MACE, ROBERT U. 1957. Oregon's mule deer. Oregon State Game Comm. Wildlife Bull. No. 3, 25 pp.

Bitterbrush is a key species on many mule deer ranges.

MARTINSEN, CHARLES FREDERICK. 1960. The effects of summer utilization of bitterbrush in northcentral Washington. Master's thesis, Univ. of Idaho, Moscow, 69 pp.

Use of bitterbrush before August was detrimental to plant condition and forage production. No adverse effect was noted from use after August. Plants were clipped either in June, August, or October for 6 years; the June plots showed the most hedging and decadence and the largest increase in deadwood.

MASON, ELLIS. 1952. Food habits and measurements of Hart Mountain antelope. J. Wildlife Manage. 16(3): 387-389.

Analysis of 26 stomach samples (2 to 3 each month) over 1 year showed that bitterbrush was used very heavily (36 percent of diet) in July and lightly (1 percent) in August. Bitterbrush was not found in samples in any other month.

MASON, LAMAR R., HORACE M. ANDREWS, JAMES A. CARLEY, and E. DWAIN HAACKE. 1967. Vegetation and soils of No Man's Land Mesa relict area, Utah. J. Range Manage. 20(1): 45-49.

Two range sites in this piñon-juniper relict area are recognized on the basis of soil differences and their resulting differences in vegetation. Vegetation and soils of the two sites are described. Bitterbrush production averaged 30 lbs. per acre and 2 lbs. per acre, respectively, on deep, loamy fine sands and on shallow, very fine sandy loam.

MILLER, DONALD F. 1958. Composition of cereal grains and forages. Nat. Acad. Sci., Nat. Res. Counc. Pub. 585, 663 pp.

Lists for bitterbrush foliage the proximate composition (NFE, ash, fiber, ether extract, crude protein) in immature, flowering, and mature stages, and gives information on mineral composition.

MIROV, N. T., and CHARLES J. KRAEBEL. 1939. Collecting and handling seeds of wild plants. Civilian Conserv. Corps Forest Pub. 5, 42 pp.

Gives data on seed and cultural treatment of bitterbrush.

MITCHELL, GLENN E. 1950. Wildlife-forest relationships in the Pacific Northwest Region. J. Forest. 48(1): 26-30.

Mentions bitterbrush as important game forage on east side of Cascades.

MITCHELL, GLENN E. 1951. Status of browse on ranges of eastern Oregon and eastern Washington. J. Range Manage. 4(4): 249-253.

Mentions a 1942-43 epidemic of meadow mice (*Microtus montanus*) that killed 90 percent of the bitterbrush on large areas by girdling. This was followed by 2 years of bad grasshopper damage that killed some remaining plants and some thrifty ones.

MUEGGLER, W. F. 1967. Voles damage big sagebrush in southwestern Montana. J. Range Manage. 20(2): 88-91.

Mentions extensive bark stripping of bitterbrush by voles (*Microtus* spp.).

MUEGGLER, WALTER F. 1950. Effects of spring and fall grazing by sheep on vegetation of the Upper Snake River Plains. J. Range Manage. 3(4): 308-315, illus.

Compares the effects of fall grazing vs. spring and fall grazing by sheep for a 25-year period. Whereas fall grazing produced little change in vegetation, spring and fall grazing brought about a large increase in shrubs, including bitterbrush, and a change from good to poor range condition.

MUEGGLER, WALTER F., and JAMES P. BLAISDELL. 1958. Effects on associated species of burning, rotobeating, spraying and railing sagebrush. J. Range Manage. 11(2): 61-66, illus.

Bitterbrush was severely injured by burning, but was favored by spraying with 2, 4-D.

MUSSEHL, THOMAS W. 1960. Blue grouse production, movements, and populations in the Bridger Mountains, Montana. J. Wildlife Manage. 24(1): 60-68.

Mentions bitterbrush as an important component of the sagebrush-bitterbrush type, extending from 5,600 to 6,400 feet. Of 351 brood observations (July 1 to August 31), 41 were in the sagebrush-bitterbrush type.

NETZ, CHARLES V., CHARLES H. ROGERS, and GLENN L. JENKINS. 1940. A phytochemical and histological study of Purshia tridentata (Pursh) D.C. J. Amer. Pharm. Assoc. 29: 480-485.

Indians of Nevada treated "pathological conditions ranging from sore eyes and internal hemorrhage to measles, smallpox, and gonorrhea" with infusions, decoctions, and poultices of bitterbrush. From studies to identify the chemical constituents responsible for the purported cures, it was concluded that the curative action "was probably due to the bacteriostatic action of the tannins and the demulcent effect of the mucilage and pectin."

NORD, EAMOR C. 1956. Quick testing bitterbrush seed viability. J. Range Manage. 9(4): 193-194, illus.

Observing the growth of excised embryos is an effective method of determining viability of bitterbrush seed.

NORD, EAMOR C. 1959. Bitterbrush ecology--some recent findings. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Res. Note 148, 8 pp., illus.

Describes the range of P. tridentata and P. glandulosa in California and tells some of the habitat requirements of each.

NORD, EAMOR C. 1959. Bitterbrush plants can be propagated from stem cuttings. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Res. Note 149, 4 pp., illus.

Cuttings from greenhouse and field stock gave 51 percent and 66 percent successful rooting when treated with a 0.1 percent acid concentration of indol-3-butyric acid in talc.

NORD, EAMOR C. 1962. Was this a prize bitterbrush? J. Range Manage. 15(2): 82-83.

A 128-year-old bitterbrush from Lassen County, California, measured 12 feet high. It had a crown spread of 19-2/3 feet.

NORD, EAMOR C. Bitterbrush seed harvesting: when, where, and how. J. Range Manage. 16(5): 258-261.

Seed production varies with site and season. Good seed crops generally follow average or better moisture conditions and stem growth of 3 inches or more. A chart is given showing the seed-ripening prediction times for California.

NORD, EAMOR C. 1965. Autecology of bitterbrush in California. Ecol. Monogr. 35(3): 307-334.

"The physiological and biological factors associated with . . .occurrence, distribution, and abundance of Purshia tridentata and P. glandulosa were identified. The effects of soil, fire, grazing, tree competition, primary and secondary succession, and other factors on natural stands and the characteristics of individual bitterbrush plants were described and evaluated."

NORD, EAMOR C., and BERT KNOWLES. 1958. Rice hulls improve drilling of bitterbrush seed. U.S. Forest Serv., Calif. Forest and Range Exp. Sta. Res. Note 134, 5 pp., illus.

A bitterbrush seed-rice hull mixture in a 3:8 ratio eliminates the otherwise erratic distribution of seed usually obtained when drilling bitterbrush seed with a standard grain drill.

NORD, EAMOR C., EDWARD R. SCHNEEGAS, and HATCH GRAHAM. 1967. Bitterbrush seed collecting--by machine or by hand? J. Range Manage. 20(2): 99-103.

Hand collecting and machine collecting of seed cost $87.70 per cwt. and $190 per cwt. clean seed, respectively, for P. tridentata seed, and $47 per cwt. and $424 per cwt., respectively, for P. glandulosa seed.

NORD, EAMOR C., and GEORGE R. VAN ATTA. 1960. Saponin--a seed germination inhibitor. Forest Sci. 6(4): 350-353, illus.

Saponin (from Atriplex canescens) in concentrations of 1.0 percent or more decreased the germination of bitterbrush, but a 0.1-percent concentration of saponin increased the germination slightly.

OLSON, ROBERT J., and JOHN P. NAGLE. 1965. Adaptation tests of trees and shrubs for the intermountain area of the Pacific Northwest. Wash. Agr. Exp. Sta. Circ. 450, 43 pp.

Bitterbrush plantings of 2-0 stock at Pullman, Washington, exhibited slow growth and poor survival.

PEARSON, BENNETT O. 1957. Bitterbrush seed dormancy broken with thiourea. J. Range Manage. 10(1): 41-42.

Soaking bitterbrush seed in a 3-percent solution of thiourea for 3 to 5 minutes resulted in 85 percent or more germination. Seedings with thiourea-treated seed yielded stands of 8,000 and 9,000 seedlings per acre at the end of the first growing season. These stands represented 10 percent of the viable seed planted.

PECHANEC, J. F., G. D. PICKFORD, and GEORGE STEWART. 1937. Effects of the 1934 drought on native vegetation of the Upper Snake River Plains, Idaho. Ecology 18(4): 490-505.

Presents data on decreases in plant density resulting from drought for several classes and species of vegetation, including bitterbrush.

PECHANEC, JOSEPH F., A. PERRY PLUMMER, JOSEPH H. ROBERTSON, and A. C. HULL, JR. 1965. Sagebrush control on rangelands. U.S. Dep. Agr. Handbook 277, 40 pp.

Describes effect of fire, herbicides, chaining, etc., on bitterbrush.

PECHANEC, JOSEPH F., and GEORGE STEWART. 1949. Grazing spring-fall sheep ranges of southern Idaho. U.S. Dep. Agr. Circ. 808, 34 pp.

Bitterbrush is often a component of sagebrush range in good condition. Sheep prefer bitterbrush more in late spring than in early spring.

PECHANEC, JOSEPH F., GEORGE STEWART, and JAMES P. BLAISDELL. 1954. Sagebrush burning--good and bad. U.S. Dep. Agr. Farmer's Bull. 1948, 34 pp.

Much bitterbrush is destroyed or severely damaged by fire in sagebrush.

PECHANEC, JOSEPH F., GEORGE STEWART, A. PERRY PLUMMER, and others. 1954. Controlling sagebrush on range lands. U.S. Dep. Agr. Farmer's Bull. 2072, 36 pp.

Most methods for sagebrush control (burning, plowing, railing, beating, spraying) damage the associated bitterbrush plants, but the latter often resprout from the base to partially offset the damaging effect of treatment.

PETERSON, ROALD A. 1953. Comparative effect of seed treatments upon seedling emergence in seven browse species. Ecology 34(4): 778-785.

Describes effects of seed treatments on bitterbrush:

stratification only produced highest emergence and potential germination;
scarification + stratification produced slightly lower emergence but substantially lower potential germination;
hot water + stratification inhibited germination;
exposure to winter conditions, with and without scarification yielded poorest results.

PICKFORD, G. D. 1932. The influence of continued heavy grazing and of promiscuous burning on spring-fall ranges in Utah. Ecology 13(2): 159-171.

In Great Salt Lake Valley, bitterbrush increased in density on grazed areas.

PLUMMER, A. PERRY, A. C. HULL, JR., GEORGE STEWART, and JOSEPH H. ROBERTSON. 1955. Seeding rangelands in Utah, Nevada, southern Idaho, and western Wyoming. U.S. Dep. Agr. Handbook 71, 73 pp.

Instructions on where, when, and how to seed bitterbrush.

PURSH, FREDERICK. 1814. Flora Americae Septentrionalis; or, a systematic arrangement and description of the plants of North America. 2 v., illus. London: White, Cochrane, and Co.

Bitterbrush was first placed with Tigarea. It was in the Lewis and Clark herbarium.

REID, ELBERT H. 1948. Forest grazing in the Pacific Northwest. Soc. Amer. Forest Proc. 1947: 296-302.

Mentions bitterbrush in a community description.

REYNOLDS, TEMPLE A., JR. 1960. The mule deer--its history, life history, and management in Utah. Utah State Dep. Fish and Game Inform. Bull. 60-4, 32 pp.

Bitterbrush is a dietary staple for mule deer in Utah.

RHODENBAUGH, BETH. 1955. Bitterbrush laboratory. Idaho Wildlife Rev. 8(2): 4-6.

Popular article on revegetation studies involving bitterbrush.

ROBERTSON, J. H., and C. TORELL. 1958. Phenology as related to chemical composition of plants and to cattle gains on summer ranges in Nevada. Nevada Agr. Exp. Sta. Tech. Bull. 197, 38 pp.

Bitterbrush is a good source of crude protein, NFE, and crude fat.

ROBINETTE, W. LESLIE, ODELL JULANDER, JAY S. GASHWILER, and JUSTIN G. SMITH. 1952. Winter mortality of mule deer in Utah in relation to range condition. J. Wildlife Manage. 16(3): 289-299.

Mentions bitterbrush as a very desirable forage.

ROBINSON, C. S. 1931. Feeding habits and forage requirements of Rocky Mountain mule deer in the Sierra Nevada Mountains. J. Forest. 29(4): 557-564.

Notes food preferences of deer throughout the season. Bitterbrush, a choice browse, had very slight use in June, yet there was ample evidence of deer numbers.

RUMMELL, ROBERT S. 1951. Some effects of livestock grazing on ponderosa pine forest and range in central Washington. Ecology 32(4): 594-607.

Bitterbrush occurs as a scattered plant in open ponderosa pine and in mixed ponderosa--Douglas-fir.

SAMPSON, A. W. 1924. Native American forage plants. 435 pp. New York: John Wiley & Sons.

Bitterbrush produces solid fat on livestock that is not readily lost during adverse weather or when the animals are shipped long distances.

SAMPSON, ARTHUR W. 1961. California brushlands--their characteristics and utility. Soc. Amer. Forest. Proc. 1960: 173-180.

The decline of bitterbrush--an important component of the sagebrush community--leads to a need for artificial revegetation.

SANDERSON, H. REED. 1962. Survival of rodent cached bitterbrush seed. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Res. Note 211, 3 pp.

Seedlings and young plants of bitterbrush are generally scarce in northeastern California, but in the spring of 1960 a large flush of seedlings emerged from rodent caches. Seedlings that had to compete with native vegetation and cheatgrass failed to survive. Where vegetation had been removed, the survival was excellent. Caches produced 1 to 25 seedlings; altogether, about 1,300 groups of seedlings emerged per acre.

SANDERSON, H. REED, and RICHARD L. HUBBARD. 1961. Bitterbrush seed spotting on wildfire burns. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Res. Note 192, 7 pp., illus.

Fall seeding is better than spring seeding. Treatments with repellents are more important on fall seedings than on spring seedings. Recommends fall spot-seeding on burned areas that are too steep for machinery.

SANDERSON, H. REED, RICHARD L. HUBBARD, and DONALD W. SEEGRIST. 1963. Effects of grass competition on bitterbrush: second-year report. U.S. Forest Serv. Res. Note PSW-26, 7 pp.

Competition from other plants, mainly perennial grasses, significantly reduced bitterbrush growth.

SANDERSON, REED, and DON McINTOSH. 1961. Effect of combined endrin-arasan 75 and thiourea treatments on the germination of bitterbrush seed. U.S. Forest Serv., Pacific Southwest Forest and Range Exp. Sta. Res. Note 174, 7 pp.

Seed from nine sources were treated with endrin-arasan 75 (rodent repellent) and thiourea (to break dormancy). Seed from only two of the nine sources showed reduced germination from the double treatment, so the combination treatment can be recommended. However, it is advisable to treat and test small samples before using the entire lot of seed, because of the erratic results with seed from the two sources.

SCHNEEGAS, EDWARD R. 1965. Aspen snag yields record bitterbrush seed cache. J. Range Manage. 18(1): 34-35.

Approximately 10 pounds of cleaned bitterbrush seed were found cached in an old, hollow aspen tree. Seed were believed to have been cached either by the golden-mantled ground squirrel (_Citellus lateralis_) or by chipmunks (_Tamias_ spp.).

SEEGRIST, DONALD W., DONALD L. NEAL, and RICHARD L. HUBBARD. 1966. Measuring bitterbrush seed production on plants with variable crown density . . . complete counts per plant suggested. U.S. Forest Serv. Res. Note PSW-130, 4 pp.

The variance of number of seeds per trap was high and could not be reduced to an acceptable level by stratifying trap position relative to plant canopy. Thus, complete seed counts per plant are recommended.

SHORT, HENRY L., DONALD R. DIETZ, and ELMER E. REMMENGA. 1966. Selected nutrients in mule deer browse plants. Ecology 47(2): 222-229.

In bitterbrush, "the percentage dry matter and crude fat, and the caloric content varied from high autumn-winter levels to low spring-summer values; and beta carotene and percentage protein, ash, phosphorus, potassium, calcium, sodium, and magnesium levels varied from low autumn-winter values to high spring-summer values."

SHORT, HENRY L., and ELMER E. REMMENGA. 1965. Use of fecal cellulose to estimate plant tissue eaten by deer. J. Range Manage. 18(3): 139-144.

Mule deer were fed on browse diets that included bitterbrush, sagebrush, and mountain-mahogany. Discusses relationships between digestible energy and the dry matter, cellulose, lignin, and hemicellulose content of the feed and presents prediction equations relating feed intake and fecal production. Suggests that forage consumption by deer can be predicted from fecal cellulose.

SMITH, ARTHUR D. 1950. Feeding deer on browse species during winter. J. Range Manage. 3(2): 130-132.

Based on the average daily consumption, bitterbrush ranked third among 17 browse species fed to two captive mule deer from January 2 to March 9.

SMITH, ARTHUR D. 1952. Digestibility of some native forages for mule deer. J. Wildlife Manage. 16(3): 309-312.

Using standard digestion trials with penned mule deer, it appeared that curlleaf mahogany is better than bitterbrush, and juniper is poorest of the three from the standpoint of amount and character of digestible nutrients. Digestibility coefficients for alfalfa hay appeared to be equal for deer and sheep.

SMITH, ARTHUR D. 1953. Consumption of native forage species by captive mule deer during summer. J. Range Manage. 6(1): 30-37, illus.

Penned deer were fed various browse and forb species, including bitterbrush, from May to October. Except in early May, browse was more important in the diet than forbs. Based on volume consumed, bitterbrush ranked low in the scale as compared with other browse plants.

SMITH, ARTHUR D. 1957. Nutritive value of some browse plants in winter. J. Range Manage. 10(4): 162-164.

Digestible nutrients of several browse plants, including bitterbrush, were compared with nutrients in some common livestock feeds.

SMITH, ARTHUR D. 1964. Evidence of hybridization between certain browse plants. J. Range Manage. 17(5): 269-272.

Discusses the occurrence of natural hybrids between *P. tridentata* and *Cowania stansburiana*.

SMITH, ARTHUR D. 1965. Determining common use grazing capacities by application of the key species concept. J. Range Manage. 18(4): 196-201.

Correct substitution rates of one grazing animal for another on common use range depends on the utilization standard of a single plant species, but this species may vary depending upon the numbers of each class of animal involved. Presents several examples based on utilization data of ranges containing bitterbrush and grazed by deer and cattle or deer and sheep.

SMITH, ARTHUR D., and RICHARD L. HUBBARD. 1954. Preference ratings for winter deer forages from northern Utah ranges based on browsing time and forage consumed. J. Range Manage. 7(6): 262-265.

Captive deer were fed 15 browse species. Bitterbrush ranked fourth and fifth, based on the time spent and forage consumed, respectively. *Cercocarpus ledifolius* X *C. montanus* hybrid, *C. ledifolius*, and *Cowania stansburiana* ranked first, second, and third. Oak (*Q. utahensis*) ranked fourth, based on forage eaten.

SMITH, ARTHUR D., ROBERT B. TURNER, and GRANT A. HARRIS. 1956. The apparent digestibility of lignin by mule deer. J. Range Manage. 9(3): 142-145.

Digestion coefficients were calculated by both the direct method and the lignin-ratio technique for several browse species, including bitterbrush. Because the two methods gave markedly different digestion values, it was concluded that the lignin-ratio technique is of doubtful reliability for the browse species tested.

SMITH, ARTHUR D., and PHILIP J. URNESS. 1962. Analyses of the twig-length method of determining utilization of browse. Utah State Dep. Fish and Game Pub. 62-9, 34 pp.

Reliability of this method of determining browse utilization was tested on several species, including bitterbrush. Variability due to observer error was small for bitterbrush. A sample of 25 to 35 plants appears adequate for a reliable estimate of use on bitterbrush at levels of use above 50 percent. Larger samples would be needed under light use.

SMITH, DIXIE R. 1960. Description and response to elk use of two mesic grassland and shrub communities in the Jackson Hole region of Wyoming. Northwest Sci. 34(1): 25-36, illus.

Mentions bitterbrush as showing "a strong preference for transported soils . . ."; also a tendency to decrease under game use. Bitterbrush is a component of the big sagebrush/needle-and-thread faciation.

SMITH, DWIGHT R. 1954. The bighorn sheep in Idaho, its status, life history, and management. Idaho Dep. Fish and Game Wildlife Bull. 1, 154 pp.

Bitterbrush receives heavy use from bighorn sheep in the Salmon River area. Many bitterbrush plants are dying, and reproduction is practically nil.

SMITH, JUSTIN G. 1952. Food habits of mule deer in Utah. J. Wildlife Manage. 16(2): 148-155, illus.

Bitterbrush showed a higher degree of use (36 percent) than any other species on the winter range; it comprised 21 percent of the deer diet.

SMITH, JUSTIN G., and ODELL JULANDER. 1953. Deer and sheep competition in Utah. J. Wildlife Manage. 17(2): 101-112.

Bitterbrush constituted 17 percent of the fall diet of sheep. It was closely hedged on deer winter range that was also used by sheep in fall, indicating that deer and sheep are in direct competition for this species.

SMITH, R. S., JR., R. F. SCHARPF, and E. R. SCHNEEGAS. 1965. Frost injury to bitterbrush in eastern California. U.S. Forest Serv. Res. Note PSW-82, 4 pp., illus.

In the spring of 1964, a 9-day warm period with temperatures up to 70° F. induced bitterbrush to break dormancy and start shoot elongation. Next followed a 3-day frost with daily minimum temperatures down to 17° F., causing a widespread dieback of bitterbrush.

SPENCER, DONALD A. 1954. Rodents and direct seeding. J. Forest. 52(11): 824-826.

Bitterbrush seed can be protected from rodents by treating with tetramine.

STANTON, FRANK WEBSTER. 1959. Autecological studies of bitterbrush (*Purshia tridentata* (Pursh) D.C.). Ph.D. thesis, Oreg. State Univ., Corvallis, 203 pp.

STEWART, GEORGE, W. P. COTTAM, and SELAR S. HUTCHINGS. 1940. Influence of unrestricted grazing on northern salt desert plant associations in western Utah. J. Agr. Res. 60(5): 289-316.

Bitterbrush is mentioned as a component of the juniper-pinyon belt.

STEWART, GEORGE, R. H. WALKER, and RAYMOND PRICE. 1939. Reseeding range lands of the intermountain region. U.S. Dep. Agr. Farmer's Bull. 1823, 25 pp.

Mentions bitterbrush as an indicator of site conditions favorable to better forage grasses.

STODDART, L. A. 1944. Gains made by cattle on summer range in northern Utah. Utah Agr. Exp. Sta. Bull. 314, 24 pp.

Mentions bitterbrush in a community description.

STODDART, L. A., and J. E. GREAVES. 1942. The composition of summer range plants in Utah. Utah Agr. Exp. Sta. Bull. 305, 22 pp., illus.

Gives data on four-year collections of bitterbrush (June-September each year) from northern Utah ranges. Bitterbrush was consistently low in ash, Mg, and S both in early and late season collections, and in P and Ca in late season only. It was consistently high in crude fiber and in Ca:P ratio in early and late season, and in crude fat in late season only. Compared with grasses and forbs, bitterbrush was high in fat and nitrogen-free extract and showed much less seasonal variation in chemical composition.

STODDART, L. A., and D. I. RASMUSSEN. 1945. Deer management and range livestock production. Utah Agr. Exp. Sta. Circ. 121, 17 pp.

On southern Utah foothill and ponderosa pine ranges, bitterbrush is an excellent source of forage for both livestock and deer.

THOMAS, LINDSEY KAY, JR. 1957. Introgression in *Purshia tridentata* (Pursh) D. C. and *Cowania stansburiana* Torr. Master's thesis, Brigham Young Univ., Provo, Utah, 67 pp.

TRAIN, PERCY, JAMES R. HEINRICHS, and W. ANDREW ARCHER. 1941. Medicinal use of plants by Indian tribes of Nevada. Pp. 126-128. IN: Contributions toward a flora of Nevada. Wash., D.C.: Works Progress Admin. of Nevada.

American Indians used decoctions of bitterbrush as remedies for venereal diseases, tuberculosis, pneumonia, and several common ailments.

U.S. FOREST SERVICE. 1937. Range plant handbook. 842 pp., illus.

Presents general information on name, distribution, and palatability of bitterbrush.

U.S. FOREST SERVICE. 1948. Woody-plant seed manual. U.S. Dep. Agr. Misc. Pub. 654, 416 pp., illus.

Gives brief notes on seed size, viability, and dormancy of bitterbrush.

U.S. FOREST SERVICE. 1961. Bitterbrush grows more rapidly than native browse species in the Black Hills. Pp. 75-76. IN: Rocky Mountain Forest and Range Exp. Sta. Annu. Rep., 106 pp., illus.

Three years after planting, bitterbrush plants were larger than several native browse species in the Black Hills. Bitterbrush averaged 5.5 inches tall beneath a *Pinus ponderosa* stand, and 11.4 inches in the open on an old burn. Soil moisture was higher on the forested site than on the open site throughout the growing season. Both were south-facing slopes with shallow soil.

VOLLAND, LEONARD ALLAN. 1963. Phytosociology of the ponderosa pine type on pumice soils in the Upper Williamson River Basin, Klamath County, Oregon. Master's thesis, Oreg. State Univ., Corvallis, 166 pp.

WAGLE, R. F., and J. VLAMIS. 1961. Nutrient deficiencies in two bitterbrush soils. Ecology 42(4): 745-752, illus.

Describes tests of potted *P. tridentata*, *P. glandulosa*, and Romaine lettuce on two California soils. One soil lacked nitrogen, one lacked phosphorus. Root nodules were found on *P. tridentata* on basaltic soil; no nodules were present on plants grown in pumice soil. Lettuce is useful as an indicator species.

WAGLE, ROBERT FAY. 1958. Early growth in bitterbrush and its relation to environment. Ph.D. thesis, Univ. of Calif., Berkeley, 271 pp.

WEAVER, HAROLD. 1957. Effects of prescribed burning in second growth ponderosa pine. J. Forest. 55(11): 823-826. Prescribed burning eliminates bitterbrush, which is "obnoxious" in its ability to come in after logging, and is replaced by Idaho fescue.

WEAVER, HAROLD. 1959. Ecological changes in the ponderosa pine forest of the Warm Springs Indian Reservation in Oregon. J. Forest. 57(1): 15-20.

Advocates prescribed burning in ponderosa pine to eliminate reproduction thickets of associated tree species and bitterbrush.

WEST, NEIL E. 1966. Matrix cluster analysis of montane forest vegetation of the Oregon Cascades. Ecology 47(6): 975-980.

Mentions bitterbrush in community description.

WILKINS, BRUCE T. 1957. Range use, food habits, and agricultural relationships of the mule deer, Bridger Mountains, Montana. J. Wildlife Manage. 21(2): 159-169.

Bitterbrush is the most important species in fall. There is a decided decline in use in winter, a continuing decrease in spring, and an increasing use of big sagebrush. Cites other workers who found the same use patterns, and suggests it may be due to a decreasing availability of bitterbrush rather than a declining digestibility hinted at by other workers.

WILLIAMS, THOMAS A. 1898. A report upon the grasses and forage plants and forage conditions of the eastern Rocky Mountain region. U.S. Dep. Agr., Div. of Agrostology, 78 pp.

Bitterbrush is mentioned as a component of higher foothills and mountains and extensively eaten by stock.

WOOLFOLK, E. J. 1960. Improving California's deer ranges to meet increasing demands for hunting. Soc. Amer. Forest Proc. 1959: 170-172.

Summarizes when, where, and how to plant bitterbrush.

YOUNG, STANFORD. 1958. Exclosures in big game management in Utah. J. Range Manage. 11(4): 186-190, illus.

Bitterbrush withstands continued overuse by assuming an impenetrable hedgelike growth form but reverts to an open, bushy form after 2 or 3 years of protection.

Basile, Joseph V.
1967. An annotated bibliography of bitterbrush (Purshia tridentata (Pursh) DC.). U.S. Dep. Agr., Forest Serv., Intermountain Forest and Range Exp. Sta., Ogden, Utah. 27 pp. (U.S. Forest Serv. Res. Pap. INT-44.)

Bitterbrush, a highly nutritious shrub relished by big game and livestock, is an important browse component on many western ranges. Its serious depletion over much of its range has focused considerable attention on restoring bitterbrush through revegetation and management programs. This bibliography is intended to aid persons engaged in these programs.

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Project headquarters are also at:

- Boise, Idaho
- Bozeman, Montana (in cooperation with Montana State University)
- Logan, Utah (in cooperation with Utah State University)
- Missoula, Montana (in cooperation with University of Montana)
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